A Treatise on The Haunched and Drawbored Mortise & Tenon Joint

by Bob Smalser

One of the strongest joints, the haunched and drawbored mortise and tenon is one of the few that resists stresses in any direction, to include tension, and is a joint that will remain fully functional long after any glue has deteriorated to dust. A basic joint used to join structural members, I'll walk you through cutting one today by hand to join the top rail to its post for a small work table done in hard maple. Why by hand? Not because I'm some hand tool reactionary…I use machines for the jobs they do best and hand tools for the jobs they do best…but there are some joinery principles best displayed and photographed using hand tools, and as most teaching today involves machines almost exclusively, newcomers tend to miss the parts where the cheaper hand tool does the job much, much more efficiently than the expensive machine, especially on smaller hobby projects.

Plus, not enjoying any subsidies from major machine or hand tool manufacturers or retailers, I'm free to provide counsel on what's best for you…not what's best for my sponsors.

The basic joinery tools I'll use are shown at left. None except the shop-made mallet are newer than 30 years old and some are almost a century old…yet I could replace all of them in a few months of shopping at flea markets and collectible tool auctions for less than 200 dollars, simply because my first training four decades ago as a teenager in a boatyard was in basic hand tool sharpening and maintenance.

Yes, the shoulder plane is relatively expensive, but they are indispensable even for machine woodworking and sound but scuffed ones like this Stanley #93 can still be had in the 60-dollar range. Three-tined adjustable mortise gages along with the old Disston saws can be found used for less than 20 dollars, and the large mortise chisel is a recent acquisition as part of a salvage chisel lot that cost less than 5 dollars.

My point is that a newcomer's first steps shouldn't be making furniture for the house or that first fancy dinghy, they should be acquiring and tuning the necessary

tools and learning to use them in traditional construction of simple benches, shelves, assembly tables, horses and jigs for your first shop. Why traditional construction? Because it's study, and practice with hand tools will teach you more about your material…wood…than machines will, and it never ceases to amaze me how little even some advanced craftsmen understand about their material. Hand tools allow you to feel how steel wants to move in cutting wood based on the grain of the wood and creates an understanding that applies to obtaining clean cuts using machine tools as well. It will pay off in the long run to your pocketbook, your enjoyment and your skills, as it's easier on all to make those first irreversible mistakes in 50 cents worth of maple than 80 dollars worth of mahogany.

The mortise should be cut first, and I'll chop one with the chisel. This is a long, millwright's mortise chisel made by James Swan almost a century ago. It's not a *framing* or *firmer* chisel as described by many tool dealers or collectors, it was manufactured primarily to chop mortises in window, door and millwork factories more than for tradesmen, who generally used smaller *sash* mortise chisels more easily carried in a carpenter's box or shipwright's chest. All mortise chisels come in widths to match the intended mortise, but these millwright chisels are much longer and easier to hold plumb, much heavier, and combined with the right mallet, much more powerful. And with power comes speed and efficiency.

I set the mortise gage to the exact width of the chisel…

…and use it to lay out both mortise and tenon on the squared-up stock. I darkened my lines with a pencil and drew some otherwise unneeded lines for clarity, but laying out your joints should be done with marking knife and awl, not a pencil. The knife used across the grain and the awl used with the grain is not only more precise, it provides accurate recesses to index chisel or saw, and as you will see, scribes the wood sufficiently to prevent unwanted splitting and chipping while cutting or chopping.

This is a 6/4 by 3" post and a 5/4 by 2" rail, and I'll do a ¾ by 1¼" mortise (+ a 16th of an inch over) deep to house a 1½" long tenon. Mortises should always be slightly over deep to allow room for glue squeeze out. A ⅞" wide mortise would also be acceptable here. The *haunch* is the 45° tenon stub I've drawn

on the upper face profiles of the stock that increases the gluing surface and aids in the joint resisting twisting stress.

You can also see in this photo that if the rail is to be flush with the post top, then I've crosscut the post too long. You are correct, I have. The post's short grain on the topside of the mortise will be far too fragile to chop a mortise and haunch without pre-drilling…and pre-drilling is unnecessarily slow, so I'll chop my mortises vigorously and trim the tops of the posts later.

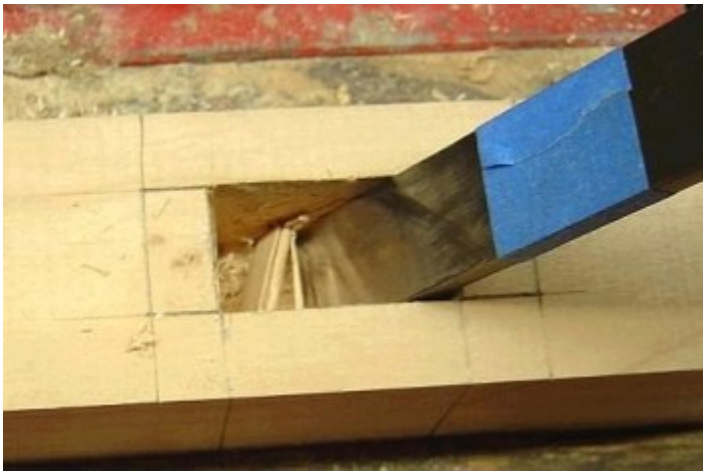
The first two chops are plumb to the work piece and just a bit inboard of the mortise ends. Inboard because that lead-weighted hard maple mallet weighs over two pounds, the bevel on this striking chisel is a steep 35°, and hard blows downward tend to push the chisel backwards just a tad. Although it is the cheeks of the mortise that provide the majority of gluing strength, avoiding unnecessary stress or damage at the ends is simply better craftsmanship. I've also marked my required mortise depth on the chisel using masking tape.

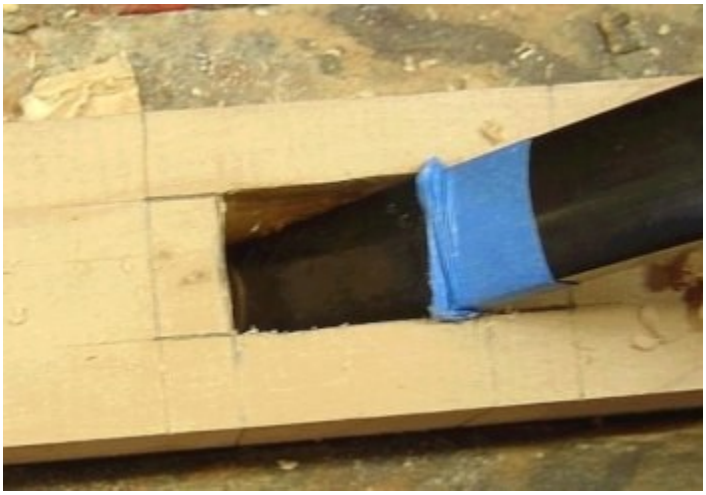
The third blow is taken bevel up about a third of the way along the mortise's length at an angle downward toward the end…

…and the waste levered out, splitting along the grain of the wood. The deep scribe marks from the mortise gage prevent any chip out.

The fourth blow is identical from the opposite direction and that waste levered out. Subsequent blows continue with two plumb blows at each end followed by two angled blows and levering out waste…

…as the mortise gets deeper, the obstruction of the mortise ends force the angled blows increasingly steeper, eventually preventing them from reaching within clean splitting distance from the end blows…the chisel is then flipped and the angled blows struck bevel down to keep the cutting angle sufficiently acute for clean, four-chop split outs.

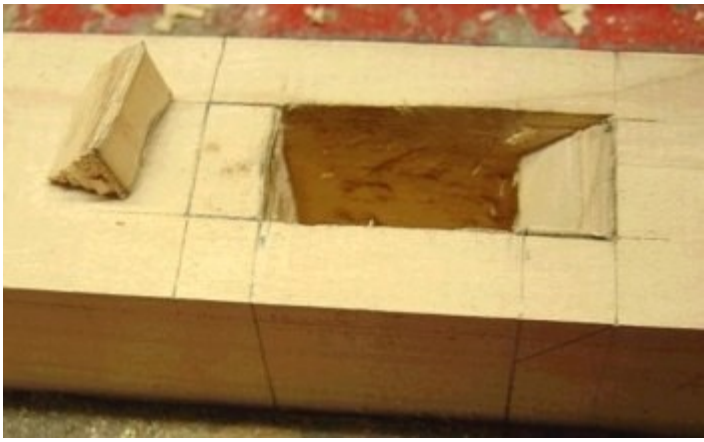


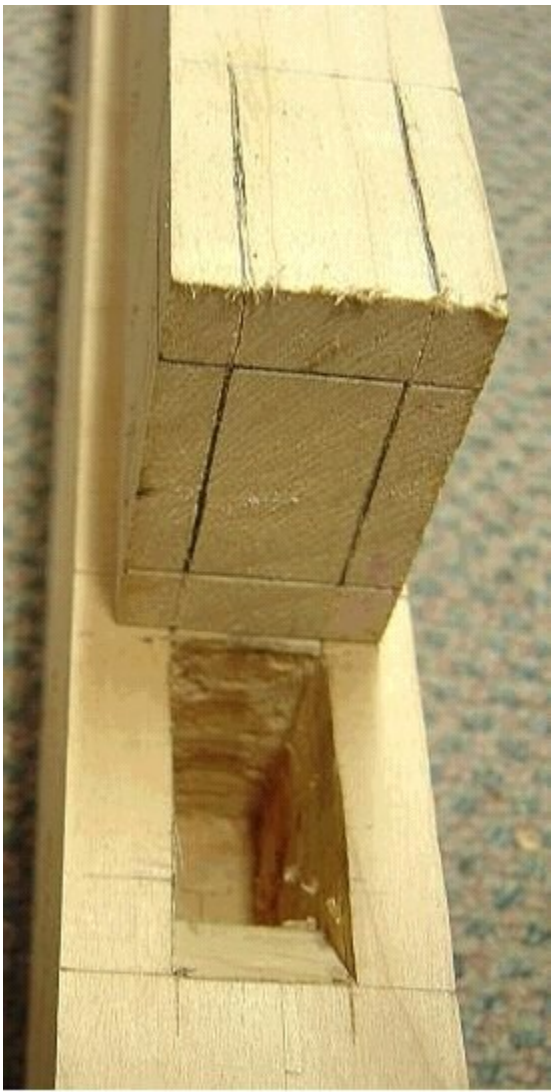


Upon reaching the correct depth, the mortise bottom is squared and cleaned by lightly striking the chisel with the bevel instead of the blade back indexed against the mortise end …

…and the top of the chisel bevel used as a fulcrum to scrape the mortise bottom with the edge of the tool. The added leverage of the longer length and larger bevels of these heavier mortise chisels also make this an incredibly clean and efficient technique to get out that last 16th of depth, if you find yourself a tad short.

The haunch is chopped by lightly striking its outline…

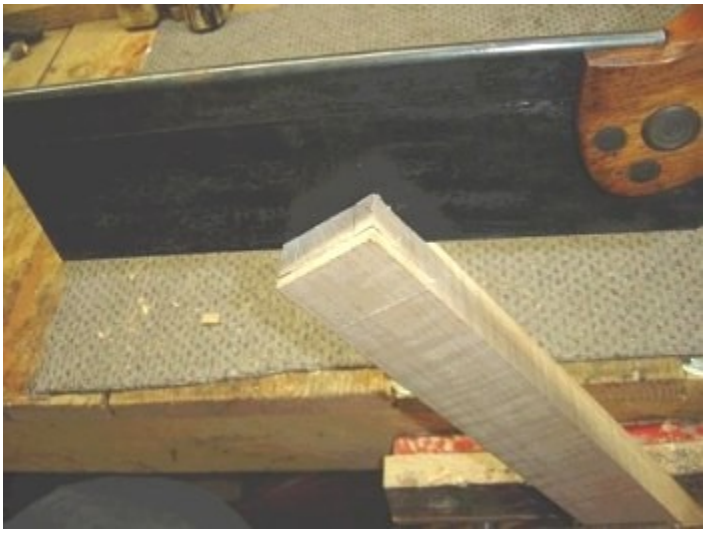




…then using a bevel gauge or sight line to line up one, clean 45° chop. These can also be cut square and a corresponding notch made in the post. Unlike the square ones, the angled one I'm using today is completely hidden…and technically should be called a *miter haunched drawbore mortise and tenon* but that's a bit of a mouthful for a subject line.

The end result is a clean, accurate mortise done in mere minutes. Depending on the size of the mortise…in average-sized furniture stock and using the right tools, they can be chopped at the rate of between 6 and 20 per hour with very little practice at it…on many pieces faster than the time needed to set up and test a router jig.

The tenon cheeks can be cut with the back saw, table saw and tenoning jig, band saw, or crosscut on the table saw using the stack dado set. It doesn't much matter... just insure that you cut to the **outside** of your scribed lines for a slightly fat fit to be shaved down lightly with the shoulder plane.

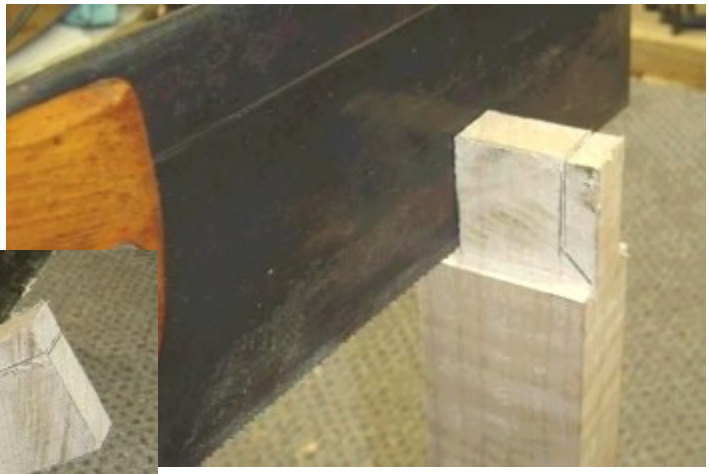


Why? Well, this especially applies to crosscutting with the dado set, but to a lesser extent applies to many saw cuts. Sawn surfaces aren't perfectly clean…that fuzzy surface is composed of tiny bits of short grain most noticeable in crosscut tenons…and that short grain does not provide the high quality glue bond a cleaner, planed surface does. Yeah, I know, it's a small point with today's modern glues, but it's a point worth remembering because it can still be overdone, especially by neatnicks using the minimum amount of glue to avoid cleaning squeeze out.

When using handsaws, tilting the workpiece away from you and beginning at a corner is the most efficient technique for hitting the outside edge of those lines on the first try.

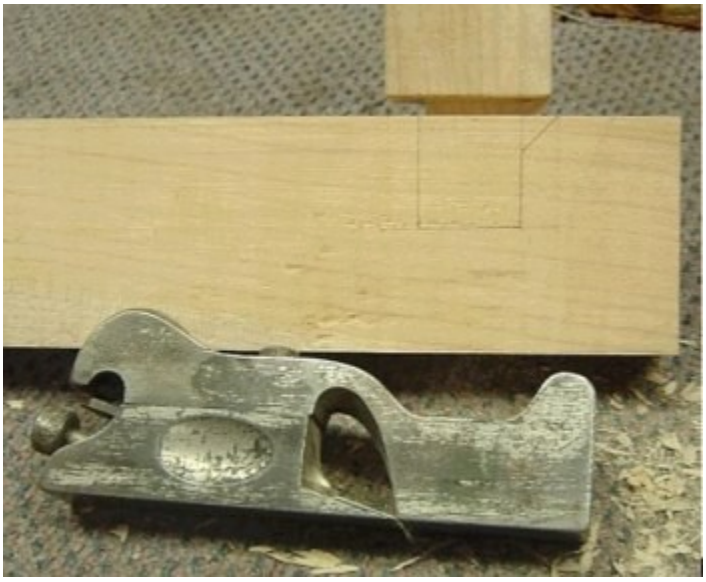
I whip out the shop-made miter box to cut the shoulders square...

...rip the lower edge of the tenon and the unmitered section of the upper edge...



...and finish the miter using the dovetail saw. The more perfect my layout and saw cuts, the less plane work will be needed...but providing I remain outside those scribed lines, even my sloppiest cuts...and there are certainly some sloppy ones here...can be easily planed to perfection.

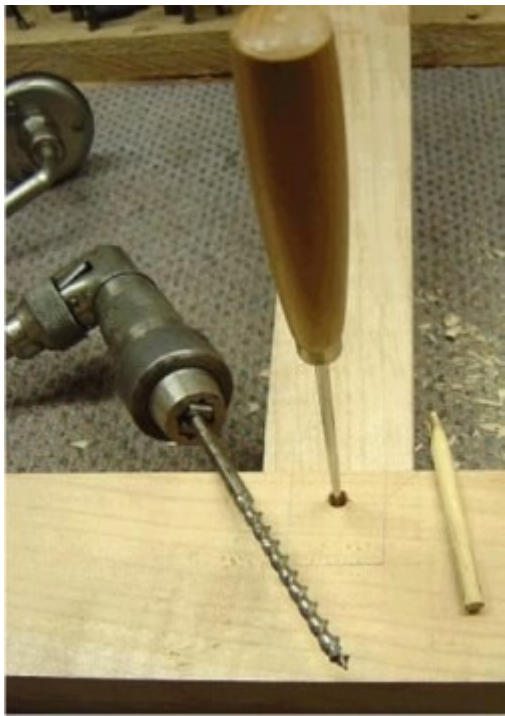
The sawn tenon shoulders are brought into perfect alignment and the tenon cheeks and edges are shaved as necessary for snug fit. A feature I like in the Stanley #93 is it is ergonomically designed to be pulled as well as pushed...because it is easier to keep your planed surface flat and square by alternating the direction of the plane when taking cross-grain shavings...and not having to reposition the work piece makes this technique very fast.



You can see from the relatively small pile of shavings that bringing the tenon from *won't fit* through *drive fit* to *snug, heel-of-the-palm, hand fit* didn't require much work. The edges of the tenon can be relatively loose compared to the tight cheeks, as chopping hard with that steep-beveled chisel has compressed the end grain at the ends of the mortise slightly...and they'll swell back some as the humidity increases.

A technique I use on fine furniture I'm shoulders inward from the edge slightly using a bench chisel. This insures a perfectly tight shoulder-post fit by removing any impediments in the tenon-shoulder corners.

To make the drawbore, I simply point a dowel and drill a plumb hole to match through both mortise cheeks...



...then dry assemble

the joint and use an ice pick from my lofting kit to mark the hole center on the tenon.

The joint is disassembled and the hole for the tenon bored a 16th or so *inboard* of the mark for the cheek holes toward the tenon shoulder…

…and I prepare for final assembly. The post is cut to final length, glue is applied, the joint assembled, and that pointed peg driven through the offset holes…

…which pulls those shoulders with considerable force against the post for a bulletproof structural joint that really needs no glue.

One pin…or two? Depends on how the piece will be used and scantling size, but every additional hole weakens that tenon, and I tend to use two pins in wider tenons than this one of an inch-and-a-quarter width.

None of this matters all that much if the joint is well constructed. Most mortise and tenon size schedules for the scantlings I'm using today call for a wider and deeper mortise…but on this piece I want some meat left in the posts in case I want to dado in a side shelf some day…

…and if this work table is ever knocked off of the loft ten feet to the concrete floor below, it's gonna break at the center of a post or rail before it breaks that joint.